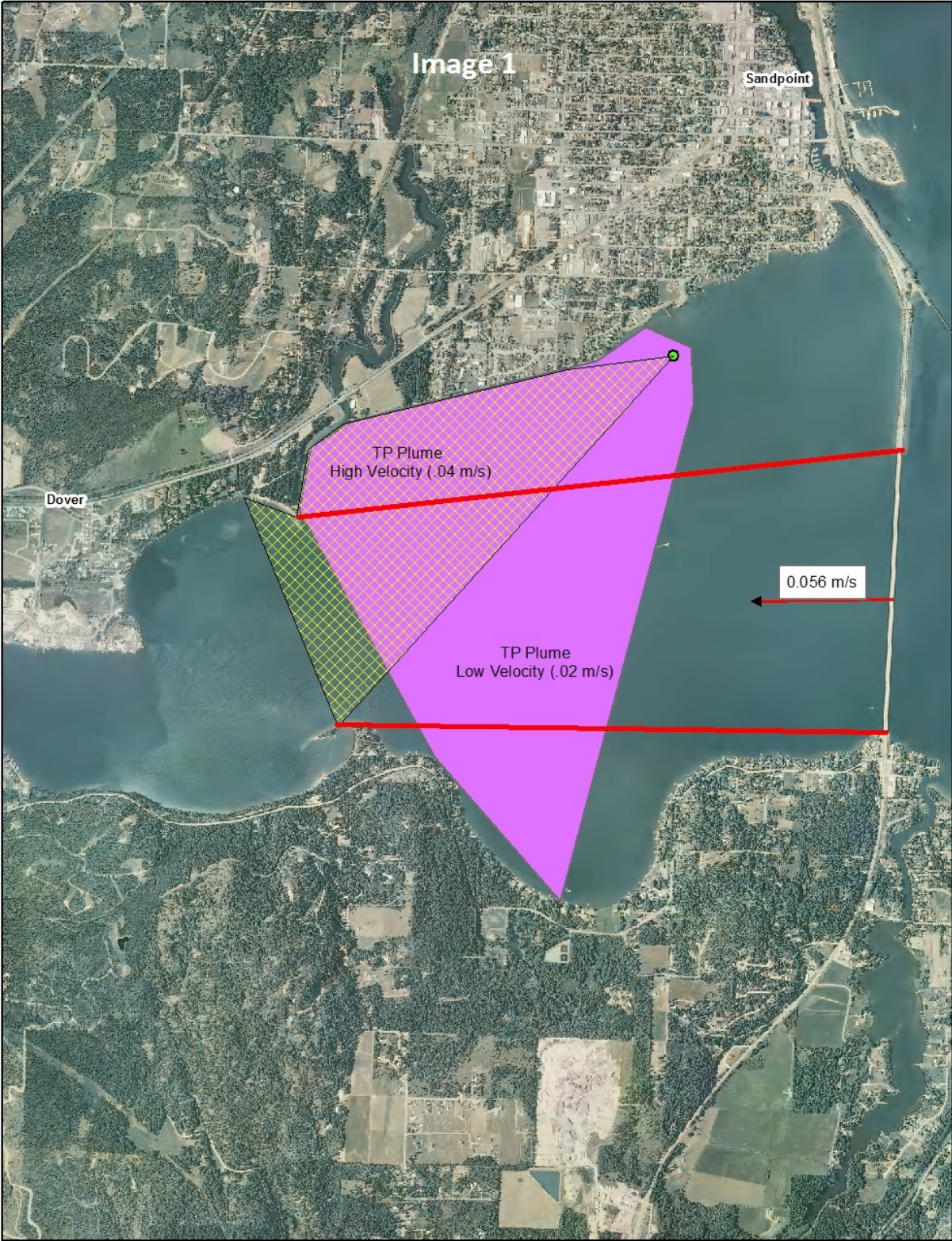


## **Appendix E**

### Cormix Modeling



# Low Velocity High Phosphorus Cormix Session Report

CORMIX SESSION REPORT:  
XX

CORMIX MIXING ZONE EXPERT SYSTEM  
CORMIX Version 8.0GTD  
HYDRO2:Version 8.0.0.0 April, 2012

SITE NAME/LABEL: Pend Oreille River - Sandpoint outfall  
DESIGN CASE: Sandpoint WWTP TP discharge to Pend Oreille River  
FILE NAME: C:\data\ALLTECH\WATER\401certs\sandpoint 2013\sandpoint run5.prd  
Using subsystem CORMIX2: Multiport Diffuser Discharges  
Start of session: 02/01/2013--09:57:01  
\*\*\*\*\*

SUMMARY OF INPUT DATA:  
-----

AMBIENT PARAMETERS:  
Cross-section BS = bounded  
Width = 2926.08 m  
Channel regularity ICHREG = 1  
Ambient flowrate QA = 239.22 m<sup>3</sup>/s  
Average depth HA = 6.71 m  
Depth at discharge HD = 5.18 m  
Ambient velocity UA = 0.0122 m/s  
Darcy-Weisbach friction factor F = 0.0167  
Calculated from Manning's n = 0.02  
Wind velocity UW = 4 m/s  
Stratification Type STRCND = A  
Surface temperature = 24 degC  
Bottom temperature = 21 degC  
Calculated FRESH-WATER DENSITY values:  
Surface density RHOAS = 997.2973 kg/m<sup>3</sup>  
Bottom density RHOAB = 997.9934 kg/m<sup>3</sup>  
-----

DISCHARGE PARAMETERS: Submerged Multiport Diffuser Discharge  
Diffuser type DITYPE = unidirectional perpendicular  
Diffuser length LD = 49.99 m  
Nearest bank = right  
Diffuser endpoints YB1 = 230.73 m; YB2 = 280.72 m  
Number of openings NOPEN = 41  
Number of Risers NRISER = 41  
Ports/Nozzles per Riser NPPERR = 1  
Spacing between risers/openings SPAC = 1.25 m  
Port/Nozzle diameter D0 = 0.0762 m  
with contraction ratio = 1  
Equivalent slot width B0 = 0.0037 m  
Total area of openings TAO = 0.1870 m<sup>2</sup>  
Discharge velocity U0 = 0.85 m/s  
Total discharge flowrate Q0 = 0.158602 m<sup>3</sup>/s  
Discharge port height H0 = 0.41 m  
Nozzle arrangement BETYPE = unidirectional without fanning  
Diffuser alignment angle GAMMA = 90 deg  
Vertical discharge angle THETA = 0 deg  
Actual Vertical discharge angle THEAC = 0 deg  
Horizontal discharge angle SIGMA = 0 deg  
Relative orientation angle BETA = 90 deg  
Discharge temperature (freshwater) = 21 degC  
Corresponding density RHO0 = 997.9934 kg/m<sup>3</sup>  
Density difference DRHO = -0.0545 kg/m<sup>3</sup>  
Buoyant acceleration GPO = -0.0005 m/s<sup>2</sup>  
Discharge concentration C0 = 2.868 mg/l  
Surface heat exchange coeff. KS = 0 m/s  
Coefficient of decay KD = 0 /s  
-----

FLUX VARIABLES PER UNIT DIFFUSER LENGTH:  
Discharge (volume flux) q0 = 0.003173 m<sup>2</sup>/s  
Momentum flux m0 = 0.002691 m<sup>3</sup>/s<sup>2</sup>  
Buoyancy flux j0 = -0.000002 m<sup>3</sup>/s<sup>3</sup>  
-----

DISCHARGE/ENVIRONMENT LENGTH SCALES:  
LQ = 0.00 m Lm = 18.11 m LM = 18.85 m  
lm' = 1.27 m Lb' = 0.33 m La = 0.34 m  
(These refer to the actual discharge/environment length scales.)  
-----

NON-DIMENSIONAL PARAMETERS:  
Slot Froude number FRO = 599.54  
Port/nozzle Froude number FRD0 = 132.83  
Velocity ratio R = 69.57  
-----

MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:  
Toxic discharge = no  
Water quality standard specified = yes  
Water quality standard CSTD = 0.01 mg/l  
Regulatory mixing zone = no  
Region of interest = 50000 m downstream  
\*\*\*\*\*

HYDRODYNAMIC CLASSIFICATION:  
\*-----\*  
| FLOW CLASS = MS4 |  
\*-----\*  
This flow configuration applies to a layer corresponding to the linearly stratified density layer at the discharge site.  
Applicable layer depth = water depth = 5.18 m  
\*\*\*\*\*



MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

X-Y-Z Coordinate system:

Origin is located at the bottom below the port center:  
255.73 m from the right bank/shore.  
Number of display steps NSTEP = 20 per module.

NEAR-FIELD REGION (NFR) CONDITIONS :

Note: The NFR is the zone of strong initial mixing. It has no regulatory implication. However, this information may be useful for the discharge designer because the mixing in the NFR is usually sensitive to the discharge design conditions.

Pollutant concentration at NFR edge  $c = 0.1396$  mg/l  
Dilution at edge of NFR  $s = 20.5$   
NFR Location:  $x = 107.08$  m  
(centerline coordinates)  $y = 0$  m  
 $z = 0.38$  m

NFR plume dimensions: half-width (bh) = 206.43 m  
thickness (bv) = 0.65 m

Cumulative travel time: 8482.125 sec.

Buoyancy assessment:

The effluent density is greater than the surrounding ambient water density at the discharge level.  
Therefore, the effluent is NEGATIVELY BUOYANT and will tend to sink towards the bottom.

IMPORTANT NOTE:

Since the effluent is NEGATIVELY BUOYANT, it is STRONGLY recommended that you consider using the Brine or Sediment options for Effluent specification for a more detailed analysis.

CORMIX will however continue with the current simulation.

Stratification assessment:

The specified ambient density stratification is dynamically important.  
The discharge near field flow is trapped within the linearly stratified ambient density layer.

UPSTREAM INTRUSION SUMMARY:

Plume exhibits upstream intrusion due to low ambient velocity or strong discharge buoyancy.

Intrusion length = 101.44 m  
Intrusion stagnation point = -97.58 m  
Intrusion thickness = 0.81 m  
Intrusion half width at impingement = 206.43 m  
Intrusion half thickness at impingement = 0.65 m

In this case, the UPSTREAM INTRUSION IS VERY LARGE, exceeding ten (10) times the local water depth.

This may be caused by the small ambient velocity, perhaps in combination with the strong buoyancy of the effluent, or alternatively, a strong ambient stratification.

If the ambient conditions are quite unsteady (e.g. tidal), then the CORMIX steady-state predictions of the upstream intrusion are probably unrealistic. The plume predictions in the immediate near-field, prior to the intrusion layer formation, are acceptable, however.

FAR-FIELD MIXING SUMMARY:

Plume becomes laterally fully mixed at 1903.43 m downstream.

PLUME BANK CONTACT SUMMARY:

Plume in bounded section contacts nearest bank at 149.25 m downstream.  
Plume contacts second bank at 1903.43 m downstream.

\*\*\*\*\* TOXIC DILUTION ZONE SUMMARY \*\*\*\*\*  
No TDZ was specified for this simulation.

\*\*\*\*\* REGULATORY MIXING ZONE SUMMARY \*\*\*\*\*  
No RMZ has been specified.

However:

The ambient water quality standard was encountered at the following

plume position:

Water quality standard = 0.01 mg/l  
Corresponding dilution  $s = 286.8$   
Plume location:  $x = 1776.60$  m  
(centerline coordinates)  $y = -255.73$  m  
 $z = 0.38$  m

Plume dimensions: half-width (bh) = 2742.25 m  
thickness (bv) = 1.36 m

\*\*\*\*\* FINAL DESIGN ADVICE AND COMMENTS \*\*\*\*\*

CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent the actual three-dimensional diffuser geometry. Thus, it approximates the details of the merging process of the individual jets from each port/nozzle.

In the present design, the spacing between adjacent ports/nozzles (or riser assemblies) is of the order of, or less than, the local water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a final CORMIX1 (single port discharge) analysis, with discharge data for an individual diffuser jet/plume, in order to compare to the present near-field prediction.



REMINDER: The user must take note that HYDRODYNAMIC MODELING by any known technique is NOT AN EXACT SCIENCE.

Extensive comparison with field and laboratory data has shown that the CORMIX predictions on dilutions and concentrations (with associated plume geometries) are reliable for the majority of cases and are accurate to within about  $\pm 50\%$  (standard deviation).

As a further safeguard, CORMIX will not give predictions whenever it judges the design configuration as highly complex and uncertain for prediction.

Jet-like motion in linear stratification with weak crossflow.

Zone of flow establishment: THETA= 0.00 SIGMA= 0.00  
 LE = 0.38 XE = 0.38 YE = 0.00 ZE = 0.41

Profile definitions:

BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory  
 BH = before merging: Gaussian 1/e (37%) half-width in horizontal plane  
       normal to trajectory  
       after merging: top-hat half-width in horizontal plane  
       parallel to diffuser line  
 S = hydrodynamic centerline dilution  
 C = centerline concentration (includes reaction effects, if any)  
 Uc = Local centerline excess velocity (above ambient)  
 TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	Uc	TT
Individual jet/plumes before merging:								
0.38	0.00	0.41	1.0	0.287E+01	0.04	0.04	0.836	.00000E+00
0.38	0.00	0.41	1.0	0.287E+01	0.04	0.04	0.836	.31834E-02
Maximum jet height has been reached.								
0.55	0.00	0.41	1.3	0.227E+01	0.06	0.06	0.782	.18551E+00
0.73	0.00	0.41	1.7	0.170E+01	0.08	0.08	0.586	.44387E+00
0.90	0.00	0.41	2.1	0.136E+01	0.09	0.09	0.471	.76657E+00
1.08	0.00	0.40	2.5	0.113E+01	0.11	0.11	0.392	.11669E+01
1.25	0.00	0.40	3.0	0.967E+00	0.13	0.13	0.336	.16379E+01
1.42	0.00	0.40	3.4	0.846E+00	0.15	0.15	0.294	.21667E+01
1.60	0.00	0.40	3.8	0.750E+00	0.17	0.17	0.261	.27755E+01
1.77	0.00	0.40	4.2	0.675E+00	0.18	0.18	0.236	.34378E+01
1.95	0.00	0.40	4.7	0.612E+00	0.20	0.20	0.214	.41818E+01
2.12	0.00	0.40	5.1	0.560E+00	0.22	0.22	0.196	.49931E+01
2.30	0.00	0.40	5.6	0.516E+00	0.23	0.23	0.181	.58518E+01
2.47	0.00	0.40	6.0	0.478E+00	0.25	0.25	0.168	.67945E+01
2.64	0.00	0.40	6.4	0.446E+00	0.27	0.27	0.157	.77806E+01
2.82	0.00	0.40	6.9	0.417E+00	0.28	0.28	0.147	.88524E+01
3.00	0.00	0.39	7.3	0.392E+00	0.30	0.30	0.138	.99885E+01
3.17	0.00	0.39	7.8	0.370E+00	0.32	0.32	0.131	.11162E+02
3.34	0.00	0.39	8.2	0.349E+00	0.33	0.33	0.124	.12424E+02
3.52	0.00	0.39	8.7	0.332E+00	0.35	0.35	0.118	.13720E+02
3.69	0.00	0.38	9.1	0.315E+00	0.37	0.37	0.112	.15105E+02
3.87	0.00	0.38	9.5	0.300E+00	0.38	0.38	0.107	.16521E+02
Cumulative travel time = 16.5209 sec ( 0.00 hrs)								
Merging of individual jet/plumes not found in this module, but interaction will occur in following module. Overall jet/plume interaction dimensions:								
3.87	0.00	0.38	9.5	0.300E+00	0.38	25.03	0.107	.16521E+02

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

BEGIN MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING

UPSTREAM INTRUSION PROPERTIES:

Maximum elevation of jet/plume rise = 3.08 m  
 Layer thickness in impingement region = 0.81 m  
 Upstream intrusion length = 101.44 m  
 X-position of upstream stagnation point = -97.58 m  
 Thickness in intrusion region = 0.81 m  
 Half-width at downstream end = 206.43 m  
 Thickness at downstream end = 0.65 m

In this case, the upstream INTRUSION IS VERY LARGE, exceeding 10 times the local water depth.

This may be caused by a very small ambient velocity, perhaps in combination with large discharge buoyancy.

If the ambient conditions are strongly transient (e.g. tidal), then the CORMIX steady-state predictions of upstream intrusion are probably unrealistic.

The plume predictions prior to boundary impingement and wedge formation will be acceptable, however.

Control volume inflow:

X	Y	Z	S	C	BV	BH	TT
3.87	0.00	0.38	9.5	0.300E+00	0.38	25.03	.16521E+02

Profile definitions:

BV = top-hat thickness, measured vertically  
 BH = top-hat half-width, measured horizontally in y-direction  
 ZU = upper plume boundary (Z-coordinate)  
 ZL = lower plume boundary (Z-coordinate)  
 S = hydrodynamic average (bulk) dilution  
 C = average (bulk) concentration (includes reaction effects, if any)  
 TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
-97.58	0.00	0.38	9999.9	0.000E+00	0.00	0.00	0.38	0.38	.84821E+04
-93.48	0.00	0.38	37.9	0.756E-01	0.20	29.19	0.48	0.28	.16521E+02
-73.43	0.00	0.38	15.8	0.182E+00	0.49	70.91	0.63	0.14	.16521E+02
-53.37	0.00	0.38	12.0	0.239E+00	0.64	95.94	0.70	0.06	.16521E+02
-33.31	0.00	0.38	10.4	0.275E+00	0.74	115.67	0.75	0.01	.16521E+02
-13.26	0.00	0.38	9.7	0.295E+00	0.79	132.50	0.79	0.00	.16521E+02
6.80	0.00	0.38	9.6	0.299E+00	0.80	188.96	0.80	0.00	.25698E+03
26.85	0.00	0.38	11.5	0.249E+00	0.78	192.97	0.78	0.00	.19020E+04
46.91	0.00	0.38	15.1	0.190E+00	0.73	196.66	0.74	0.02	.35470E+04



66.97	0.00	0.38	18.1	0.159E+00	0.68	200.11	0.72	0.04	.51921E+04
87.02	0.00	0.38	19.7	0.145E+00	0.66	203.35	0.71	0.05	.68371E+04
107.08	0.00	0.38	20.5	0.140E+00	0.65	206.43	0.71	0.06	.84821E+04

Cumulative travel time = 8482.1250 sec ( 2.36 hrs)

END OF MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING

-----  
 \*\* End of NEAR-FIELD REGION (NFR) \*\*  
 -----

BEGIN MOD242: BUOYANT TERMINAL LAYER SPREADING

Profile definitions:

BV = top-hat thickness, measured vertically  
 BH = top-hat half-width, measured horizontally in y-direction  
 ZU = upper plume boundary (Z-coordinate)  
 ZL = lower plume boundary (Z-coordinate)  
 S = hydrodynamic average (bulk) dilution  
 C = average (bulk) concentration (includes reaction effects, if any)  
 TT = Cumulative travel time

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
107.08	0.00	0.38	20.5	0.140E+00	0.65	206.43	0.71	0.06	.84821E+04
109.19	0.00	0.38	20.8	0.138E+00	0.65	208.87	0.71	0.06	.86549E+04
111.30	0.00	0.38	21.1	0.136E+00	0.65	211.32	0.71	0.06	.88278E+04
113.40	0.00	0.38	21.4	0.134E+00	0.65	213.77	0.71	0.06	.90006E+04
115.51	0.00	0.38	21.7	0.132E+00	0.65	216.22	0.71	0.06	.91734E+04
117.62	0.00	0.38	22.0	0.130E+00	0.65	218.68	0.71	0.05	.93462E+04
119.73	0.00	0.38	22.3	0.129E+00	0.66	221.13	0.71	0.05	.95190E+04
121.84	0.00	0.38	22.6	0.127E+00	0.66	223.59	0.71	0.05	.96918E+04
123.95	0.00	0.38	22.9	0.125E+00	0.66	226.05	0.71	0.05	.98646E+04
126.05	0.00	0.38	23.2	0.124E+00	0.66	228.51	0.71	0.05	.10037E+05
128.16	0.00	0.38	23.5	0.122E+00	0.66	230.97	0.71	0.05	.10210E+05
130.27	0.00	0.38	23.8	0.120E+00	0.66	233.43	0.71	0.05	.10383E+05
132.38	0.00	0.38	24.1	0.119E+00	0.66	235.90	0.71	0.05	.10556E+05
134.49	0.00	0.38	24.4	0.117E+00	0.67	238.37	0.71	0.05	.10729E+05
136.60	0.00	0.38	24.7	0.116E+00	0.67	240.84	0.72	0.05	.10902E+05
138.70	0.00	0.38	25.0	0.115E+00	0.67	243.31	0.72	0.05	.11074E+05
140.81	0.00	0.38	25.4	0.113E+00	0.67	245.78	0.72	0.05	.11247E+05
142.92	0.00	0.38	25.7	0.112E+00	0.67	248.26	0.72	0.05	.11420E+05
145.03	0.00	0.38	26.0	0.110E+00	0.67	250.74	0.72	0.04	.11593E+05
147.14	0.00	0.38	26.3	0.109E+00	0.68	253.22	0.72	0.04	.11766E+05
149.25	0.00	0.38	26.6	0.108E+00	0.68	255.70	0.72	0.04	.11938E+05

Cumulative travel time = 11938.3955 sec ( 3.32 hrs)

-----  
 Plume is ATTACHED to RIGHT bank/shore.

Plume width is now determined from RIGHT bank/shore.

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
149.25	-255.73	0.38	26.6	0.108E+00	0.68	511.45	0.72	0.04	.11938E+05
236.96	-255.73	0.38	37.6	0.763E-01	0.80	608.60	0.80	0.00	.19128E+05
324.66	-255.73	0.38	48.2	0.595E-01	0.88	716.42	0.88	0.00	.26317E+05
412.37	-255.73	0.38	59.2	0.484E-01	0.93	829.36	0.93	0.00	.33506E+05
500.08	-255.73	0.38	70.7	0.406E-01	0.97	945.29	0.97	0.00	.40695E+05
587.79	-255.73	0.38	82.7	0.347E-01	1.01	1063.22	1.01	0.00	.47885E+05
675.50	-255.73	0.38	95.2	0.301E-01	1.05	1182.62	1.05	0.00	.55074E+05
763.21	-255.73	0.38	108.1	0.265E-01	1.08	1303.18	1.08	0.00	.62263E+05
850.92	-255.73	0.38	121.5	0.236E-01	1.11	1424.70	1.11	0.00	.69452E+05
938.63	-255.73	0.38	135.4	0.212E-01	1.14	1547.02	1.14	0.00	.76641E+05
1026.34	-255.73	0.38	149.7	0.192E-01	1.17	1670.05	1.17	0.00	.83831E+05
1114.05	-255.73	0.38	164.4	0.174E-01	1.19	1793.69	1.19	0.00	.91020E+05
1201.76	-255.73	0.38	179.4	0.160E-01	1.22	1917.88	1.22	0.00	.98209E+05
1289.47	-255.73	0.38	194.9	0.147E-01	1.24	2042.56	1.24	0.00	.10540E+06
1377.18	-255.73	0.38	210.7	0.136E-01	1.26	2167.69	1.26	0.00	.11259E+06
1464.88	-255.73	0.38	226.8	0.126E-01	1.29	2293.23	1.29	0.00	.11978E+06
1552.59	-255.73	0.38	243.3	0.118E-01	1.31	2419.15	1.31	0.00	.12697E+06
1640.30	-255.73	0.38	260.1	0.110E-01	1.33	2545.41	1.33	0.00	.13416E+06
1728.01	-255.73	0.38	277.2	0.103E-01	1.35	2671.99	1.35	0.00	.14134E+06

\*\* WATER QUALITY STANDARD OR CCC HAS BEEN FOUND \*\*

The pollutant concentration in the plume falls below water quality standard

or CCC value of 0.100E-01 in the current prediction interval.

This is the spatial extent of concentrations exceeding the water quality standard or CCC value.

1815.72	-255.73	0.38	294.6	0.973E-02	1.37	2798.88	1.37	0.00	.14853E+06
1903.43	-255.73	0.38	312.3	0.918E-02	1.39	2926.03	1.39	0.00	.15572E+06

Cumulative travel time = 155722.9688 sec ( 43.26 hrs)

Plume is laterally fully mixed at the end of the buoyant spreading regime.

END OF MOD242: BUOYANT TERMINAL LAYER SPREADING

-----  
 Due to the attachment or proximity of the plume to the bottom, the bottom coordinate for the FAR-FIELD differs from the ambient depth, ZFB = 0 m.  
 In a subsequent analysis set "depth at discharge" equal to "ambient depth".  
 -----

BEGIN MOD262: PASSIVE AMBIENT MIXING IN STRATIFIED AMBIENT

Vertical diffusivity (initial value) = 0.834E-07 m<sup>2</sup>/s  
 Horizontal diffusivity (initial value) = 0.598E-02 m<sup>2</sup>/s

```

prFile" definitions:
BV = Gaussian s.d.*sqrt(pi/2) (46%) thickness, measured vertically
    or equal to layer depth, if fully mixed
BH = Gaussian s.d.*sqrt(pi/2) (46%) half-width,
    measured horizontally in X-direction
ZU = upper plume boundary (Z-coordinate)
ZL = lower plume boundary (Z-coordinate)
S = hydrodynamic centerline dilution
    centerline concentration (includes reaction effects, if any)
TT = Cumulative travel time

```

Time Stage 2 (Bank atached):	Y	X	S	C	BV	BH	ZU	GL	TT
1903.43	-255.73	0.38	312.3	0.918E-02	1.39	2926.03	1.39	0.00	.155728+06
4308.26	-255.73	0.38	316.5	0.906E-02	1.41	2926.03	1.41	0.00	.352848+06
6713.09	-255.73	0.38	320.6	0.895E-02	1.43	2926.03	1.43	0.00	.549595+06
9117.92	-255.73	0.38	324.6	0.883E-02	1.44	2926.03	1.44	0.00	.747078+06
11522.74	-255.73	0.38	328.6	0.873E-02	1.46	2926.03	1.46	0.00	.944198+06
1387.57	-255.73	0.38	332.6	0.862E-02	1.48	2926.03	1.48	0.00	.114138+07
1633.60	-255.73	0.38	336.6	0.852E-02	1.50	2926.03	1.50	0.00	.313445+07
18737.33	-255.73	0.38	340.4	0.843E-02	1.51	2926.03	1.51	0.00	.135358+07
21142.06	-255.73	0.38	344.2	0.833E-02	1.53	2926.03	1.53	0.00	.173268+07
23546.88	-255.73	0.38	348.0	0.824E-02	1.55	2926.03	1.55	0.00	.192988+07
25951.71	-255.73	0.38	351.7	0.816E-02	1.56	2926.03	1.56	0.00	.212698+07
28356.54	-255.73	0.38	355.4	0.807E-02	1.58	2926.03	1.58	0.00	.232408+07
30761.37	-255.73	0.38	359.0	0.799E-02	1.60	2926.03	1.60	0.00	.252115+07
33166.20	-255.73	0.38	362.7	0.791E-02	1.62	2926.03	1.62	0.00	.271825+07
35571.03	-255.73	0.38	366.2	0.783E-02	1.63	2926.03	1.63	0.00	.29153E+07
37975.86	-255.73	0.38	369.8	0.776E-02	1.64	2926.03	1.64	0.00	.311258+07
40380.68	-255.73	0.38	373.3	0.768E-02	1.66	2926.03	1.66	0.00	.33096E+07
42785.51	-255.73	0.38	376.8	0.761E-02	1.68	2926.03	1.68	0.00	.35067E+07
45190.34	-255.73	0.38	380.2	0.754E-02	1.69	2926.03	1.69	0.00	.37038E+07
47595.17	-255.73	0.38	383.7	0.748E-02	1.71	2926.03	1.71	0.00	.39009E+07
50000.00	-255.73	0.38	387.0	0.742E-02	1.72	2926.03	1.72	0.00	.40980E+07
Cumulative travel time =			409808.000.000 sec			(1138.34 hrs)			

Simulation limit based on maximum specified distance = 50000.00 m.  
This is the REGION OF INTEREST limitation.

END OF MOD262: PASSIVE AMBIENT MIXING IN STRATIFIED AMBIENT

[illegible]

## High Velocity, High Phosphorus Cormix Session Report

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
CORMIX MIXING ZONE EXPERT SYSTEM
CORMIX Version 8.0GTD
HYDRO2:Version-8.0.0.0 April,2012

SITE NAME/LABEL:      Pend Oreille River - Sandpoint outfall
DESIGN CASE:          Sandpoint WWTP TP discharge to Pend Oreille River
FILE NAME:            C:\data\ALLTECH\WATER\401certs\sandpoint 2013\sandpoint run3.prd
Using subsystem CORMIX2:  Multiport Diffuser Discharges
Start of session:      02/07/2013--10:49:37
*****
SUMMARY OF INPUT DATA:
-----
AMBIENT PARAMETERS:
Cross-section          = bounded
Width                  BS = 2926.08 m
Channel regularity     ICHREG = 1
Ambient flowrate       QA = 792.87 m^3/s
Average depth          HA = 6.71 m
Depth at discharge     HD = 5.18 m
Ambient velocity        UA = 0.0404 m/s
Darcy-Weisbach friction factor F = 0.0167
Calculated from Manning's n = 0.02
Wind velocity          UW = 4 m/s
Stratification Type    STRCND = A
Surface temperature     = 24 degC
Bottom temperature     = 16 degC
Calculated FRESH-WATER DENSITY values:
Surface density        RHOAS = 997.2973 kg/m^3
Bottom density         RHOAB = 998.9443 kg/m^3
-----
DISCHARGE PARAMETERS:
Submerged Multiport Diffuser Discharge
Diffuser type          DITYPE = unidirectional perpendicular
Diffuser length        LD = 49.99 m
Nearest bank           = right
Diffuser endpoints     YB1 = 230.73 m; YB2 = 280.72 m
Number of openings     NOPEN = 41
Number of risers       NRISER = 41
Ports/Nozzles per Riser NPPERR = 1
Spacing between risers/openings SPAC = 1.25 m
Port/Nozzle diameter   D0 = 0.0762 m
with contraction ratio = 1
Equivalent slot width   B0 = 0.0037 m
Total area of openings TAO = 0.1870 m^2
Discharge velocity      U0 = 0.85 m/s
Total discharge flowrate Q0 = 0.158602 m^3/s
Discharge port height   H0 = 0.41 m
Nozzle arrangement     BETYPE = unidirectional without fanning
Diffuser alignment angle GRMA = 90 deg
Vertical discharge angle THEA = 0 deg
Actual Vertical discharge angle THEAC = 0 deg
Horizontal discharge angle SIGMA = 0 deg
Relative orientation angle BETA = 90 deg
Discharge temperature (freshwater) = 20 degC
Corresponding density   RHO0 = 998.2051 kg/m^3
Density difference      DRHO = 0.6104 kg/m^3
Buoyant acceleration    GP0 = 0.006 m/s^2
Discharge concentration C0 = 3.29 mg/l
Surface heat exchange coeff. KS = 0 m/s
Coefficient of decay     KD = 0 /s
-----
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
Discharge (volume flux) q0 = 0.003173 m^2/s
Momentum flux          m0 = 0.002691 m^3/s^2
Buoyancy flux          j0 = 0.000019 m^3/s^3
-----
DISCHARGE/ENVIRONMENT LENGTH SCALES:
LQ = 0.00 m      Lm = 1.65 m      LM = 3.77 m
lm' = 0.95 m     Lb' = 0.48 m      La = 0.72 m
(These refer to the actual discharge/environment length scales.)
-----
NON-DIMENSIONAL PARAMETERS:
Slot Froude number      FRO = 179.16
Port/nozzle Froude number FRD0 = 39.69
Velocity ratio          R = 20.99
-----
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
Toxic discharge         = no
Water quality standard specified = yes
Water quality standard   CSTD = 0.01 mg/l
Regulatory mixing zone   = no
Region of interest       = 30000 m downstream
*****
HYDRODYNAMIC CLASSIFICATION:
*-----*
| FLOW CLASS = MS4 |
*-----*
This flow configuration applies to a layer corresponding to the linearly
stratified density layer at the discharge site.
Applicable layer depth = water depth = 5.18 m
*****
```



MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

X-Y-Z Coordinate system:

Origin is located at the bottom below the port center:  
255.73 m from the right bank/shore.  
Number of display steps NSTEP = 20 per module.

NEAR-FIELD REGION (NFR) CONDITIONS :

Note: The NFR is the zone of strong initial mixing. It has no regulatory implication. However, this information may be useful for the discharge designer because the mixing in the NFR is usually sensitive to the discharge design conditions.

Pollutant concentration at NFR edge c = 0.0809 mg/l

Dilution at edge of NFR s = 40.7

NFR Location: x = 55.48 m

(centerline coordinates) y = 0 m

z = 0.51 m

NFR plume dimensions: half-width (bh) = 89.71 m

thickness (bv) = 0.89 m

Cumulative travel time: 1194.4045 sec.

Buoyancy assessment:

The effluent density is less than the surrounding ambient water density at the discharge level.  
Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards the surface.

Stratification assessment:

The specified ambient density stratification is dynamically important.  
The discharge near field flow is trapped within the linearly stratified ambient density layer.

UPSTREAM INTRUSION SUMMARY:

Plume exhibits upstream intrusion due to low ambient velocity or strong discharge buoyancy.

Intrusion length = 44.60 m

Intrusion stagnation point = -33.98 m

Intrusion thickness = 1.74 m

Intrusion half width at impingement = 89.71 m

Intrusion half thickness at impingement = 0.89 m

FAR-FIELD MIXING SUMMARY:

Plume becomes laterally fully mixed at 5904.29 m downstream.

PLUME BANK CONTACT SUMMARY:

Plume in bounded section contacts nearest bank at 373.64 m downstream.

Plume contacts second bank at 5904.29 m downstream.

\*\*\*\*\* TOXIC DILUTION ZONE SUMMARY \*\*\*\*\*  
No TDZ was specified for this simulation.

\*\*\*\*\* REGULATORY MIXING ZONE SUMMARY \*\*\*\*\*  
No RMZ has been specified.

However:

The ambient water quality standard was encountered at the following

plume position:

Water quality standard = 0.01 mg/l

Corresponding dilution s = 329.2

Plume location: x = 2763.00 m

(centerline coordinates) y = -255.73 m

z = 0.51 m

Plume dimensions: half-width (bh) = 1515.51 m

thickness (bv) = 0.85 m

\*\*\*\*\* FINAL DESIGN ADVICE AND COMMENTS \*\*\*\*\*

CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent the actual three-dimensional diffuser geometry. Thus, it approximates the details of the merging process of the individual jets from each port/nozzle.

In the present design, the spacing between adjacent ports/nozzles (or riser assemblies) is of the order of, or less than, the local water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a final CORMIX1 (single port discharge) analysis, with discharge data for an individual diffuser jet/plume, in order to compare to the present near-field prediction.

REMINDER: The user must take note that HYDRODYNAMIC MODELING by any known technique is NOT AN EXACT SCIENCE.

Extensive comparison with field and laboratory data has shown that the CORMIX predictions on dilutions and concentrations (with associated plume geometries) are reliable for the majority of cases and are accurate to within about +-50% (standard deviation).

As a further safeguard, CORMIX will not give predictions whenever it judges the design configuration as highly complex and uncertain for prediction.

## Jet-like motion in linear stratification with weak crossflow.

Zone of flow establishment: THETA= 0.00 SIGMA= 0.00  
LE = 0.38 XE = 0.38 YE = 0.00 ZE = 0.41

Profile definitions:

BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory  
BH = before merging: Gaussian 1/e (37%) half-width in horizontal plane  
normal to trajectory  
after merging: top-hat half-width in horizontal plane  
parallel to diffuser line  
S = hydrodynamic centerline dilution  
C = centerline concentration (includes reaction effects, if any)  
Uc = Local centerline excess velocity (above ambient)  
TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	Uc	TT
Individual jet/plumes before merging:								
0.38	0.00	0.41	1.0	0.329E+01	0.04	0.04	0.808	.00000E+00
0.38	0.00	0.41	1.0	0.329E+01	0.04	0.04	0.808	.32592E-02
0.89	0.00	0.41	2.1	0.157E+01	0.09	0.09	0.460	.73930E+00
1.40	0.00	0.42	3.4	0.971E+00	0.14	0.14	0.289	.20345E+01
1.91	0.00	0.43	4.7	0.698E+00	0.18	0.18	0.210	.38397E+01
2.43	0.00	0.43	6.1	0.543E+00	0.22	0.22	0.165	.61110E+01
2.94	0.00	0.44	7.4	0.444E+00	0.26	0.26	0.136	.88087E+01
3.45	0.00	0.45	8.8	0.375E+00	0.29	0.29	0.116	.11898E+02
3.96	0.00	0.46	10.2	0.324E+00	0.33	0.33	0.101	.15346E+02
4.48	0.00	0.46	11.5	0.285E+00	0.36	0.36	0.090	.19127E+02
4.99	0.00	0.47	12.9	0.255E+00	0.39	0.39	0.081	.23215E+02
5.50	0.00	0.48	14.3	0.231E+00	0.42	0.42	0.073	.27588E+02
6.01	0.00	0.48	15.6	0.210E+00	0.44	0.44	0.067	.32225E+02
6.53	0.00	0.49	17.0	0.194E+00	0.47	0.47	0.062	.37107E+02
7.04	0.00	0.49	18.3	0.179E+00	0.49	0.49	0.058	.42219E+02
7.55	0.00	0.50	19.7	0.167E+00	0.52	0.52	0.054	.47545E+02
8.06	0.00	0.50	21.0	0.157E+00	0.54	0.54	0.051	.53071E+02
8.58	0.00	0.50	22.3	0.147E+00	0.56	0.56	0.048	.58786E+02
9.09	0.00	0.51	23.6	0.139E+00	0.59	0.59	0.045	.64677E+02
9.60	0.00	0.51	24.9	0.132E+00	0.61	0.61	0.043	.70734E+02

Merging of individual jet/plumes to form plane jet/plume:

10.11	0.00	0.51	32.3	0.102E+00	0.78	25.78	0.029	.76863E+02
10.62	0.00	0.51	33.0	0.998E-01	0.81	25.80	0.028	.84323E+02

Terminal level in stratified ambient has been reached.

Cumulative travel time = 84.3234 sec ( 0.02 hrs)

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

BEGIN MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING

UPSTREAM INTRUSION PROPERTIES:

Maximum elevation of jet/plume rise	=	2.69 m
Layer thickness in impingement region	=	1.74 m
Upstream intrusion length	=	44.60 m
X-position of upstream stagnation point	=	-33.98 m
Thickness in intrusion region	=	1.74 m
Half-width at downstream end	=	89.71 m
Thickness at downstream end	=	0.89 m

Control volume inflow:

X	Y	Z	S	C	BV	BH	TT
10.62	0.00	0.51	33.0	0.998E-01	0.81	25.80	.84323E+02

Profile definitions:

BV = top-hat thickness, measured vertically  
BH = top-hat half-width, measured horizontally in y-direction  
ZU = upper plume boundary (Z-coordinate)  
ZL = lower plume boundary (Z-coordinate)  
S = hydrodynamic average (bulk) dilution  
C = average (bulk) concentration (includes reaction effects, if any)  
TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
-33.98	0.00	0.51	9999.9	0.000E+00	0.00	0.00	0.51	0.51	.11944E+04
-32.19	0.00	0.51	131.4	0.250E-01	0.44	12.69	0.73	0.30	.84323E+02
-23.43	0.00	0.51	54.7	0.601E-01	1.05	30.82	1.05	0.00	.84323E+02
-14.66	0.00	0.51	41.6	0.792E-01	1.38	41.70	1.38	0.00	.84323E+02
-5.89	0.00	0.51	36.1	0.912E-01	1.59	50.27	1.59	0.00	.84323E+02
2.88	0.00	0.51	33.6	0.979E-01	1.70	57.59	1.70	0.00	.84323E+02
11.64	0.00	0.51	33.0	0.997E-01	1.73	82.18	1.73	0.00	.10960E+03
20.41	0.00	0.51	34.3	0.959E-01	1.59	83.91	1.59	0.00	.32656E+03
29.18	0.00	0.51	36.8	0.894E-01	1.32	85.50	1.32	0.00	.54352E+03
37.94	0.00	0.51	38.9	0.845E-01	1.08	86.99	1.08	0.00	.76048E+03
46.71	0.00	0.51	40.1	0.820E-01	0.95	88.39	0.99	0.04	.97744E+03
55.48	0.00	0.51	40.7	0.809E-01	0.89	89.71	0.96	0.07	.11944E+04

Cumulative travel time = 1194.4047 sec ( 0.33 hrs)

END OF MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING

\*\* End of NEAR-FIELD REGION (NFR) \*\*

BEGIN MOD242: BUOYANT TERMINAL LAYER SPREADING

Profile definitions:



BV = top-hat thickness, measured vertically  
 BH = top-hat half-width, measured horizontally in y-direction  
 ZU = upper plume boundary (Z-coordinate)  
 ZL = lower plume boundary (Z-coordinate)  
 S = hydrodynamic average (bulk) dilution  
 C = average (bulk) concentration (includes reaction effects, if any)  
 TT = Cumulative travel time

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
55.48	0.00	0.51	40.7	0.809E-01	0.89	89.71	0.96	0.07	.11944E+04
71.39	0.00	0.51	42.3	0.778E-01	0.81	102.46	0.92	0.11	.15880E+04
87.29	0.00	0.51	43.8	0.752E-01	0.75	113.98	0.89	0.14	.19816E+04
103.20	0.00	0.51	45.1	0.729E-01	0.71	124.61	0.87	0.16	.23752E+04
119.11	0.00	0.51	46.5	0.708E-01	0.68	134.53	0.85	0.17	.27688E+04
135.02	0.00	0.51	47.8	0.689E-01	0.65	143.90	0.84	0.19	.31624E+04
150.93	0.00	0.51	49.1	0.670E-01	0.63	152.81	0.83	0.20	.35560E+04
166.83	0.00	0.51	50.4	0.653E-01	0.61	161.35	0.82	0.21	.39496E+04
182.74	0.00	0.51	51.8	0.636E-01	0.60	169.58	0.81	0.21	.43432E+04
198.65	0.00	0.51	53.1	0.619E-01	0.59	177.55	0.81	0.22	.47368E+04
214.56	0.00	0.51	54.6	0.603E-01	0.58	185.29	0.80	0.22	.51303E+04
230.47	0.00	0.51	56.0	0.587E-01	0.57	192.85	0.80	0.23	.55239E+04
246.37	0.00	0.51	57.5	0.572E-01	0.56	200.24	0.80	0.23	.59175E+04
262.28	0.00	0.51	59.1	0.557E-01	0.56	207.50	0.79	0.23	.63111E+04
278.19	0.00	0.51	60.6	0.542E-01	0.55	214.64	0.79	0.24	.67047E+04
294.10	0.00	0.51	62.3	0.528E-01	0.55	221.68	0.79	0.24	.70983E+04
310.01	0.00	0.51	63.9	0.515E-01	0.55	228.63	0.79	0.24	.74919E+04
325.91	0.00	0.51	65.6	0.501E-01	0.55	235.50	0.79	0.24	.78855E+04
341.82	0.00	0.51	67.3	0.488E-01	0.55	242.30	0.79	0.24	.82791E+04
357.73	0.00	0.51	69.1	0.476E-01	0.54	249.05	0.79	0.24	.86727E+04
373.64	0.00	0.51	70.9	0.464E-01	0.54	255.75	0.79	0.24	.90663E+04
Cumulative travel time =			9066.2852 sec ( 2.52 hrs)						

Plume is ATTACHED to RIGHT bank/shore.

Plume width is now determined from RIGHT bank/shore.

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
373.64	-255.73	0.51	70.9	0.464E-01	0.54	511.45	0.79	0.24	.90663E+04
650.17	-255.73	0.51	97.0	0.339E-01	0.62	614.81	0.82	0.20	.15908E+05
926.70	-255.73	0.51	123.3	0.267E-01	0.67	725.82	0.85	0.18	.22750E+05
1203.24	-255.73	0.51	150.8	0.218E-01	0.70	840.58	0.87	0.16	.29592E+05
1479.77	-255.73	0.51	179.6	0.183E-01	0.74	957.57	0.88	0.15	.36434E+05
1756.30	-255.73	0.51	209.7	0.157E-01	0.76	1076.07	0.90	0.13	.43276E+05
2032.83	-255.73	0.51	241.0	0.137E-01	0.79	1195.71	0.91	0.12	.50118E+05
2309.37	-255.73	0.51	273.5	0.120E-01	0.82	1316.24	0.92	0.11	.56960E+05
2585.90	-255.73	0.51	307.1	0.107E-01	0.84	1437.50	0.93	0.09	.63802E+05

\*\* WATER QUALITY STANDARD OR CCC HAS BEEN FOUND \*\*

The pollutant concentration in the plume falls below water quality standard  
 or CCC value of 0.100E-01 in the current prediction interval.

This is the spatial extent of concentrations exceeding the water quality  
 standard or CCC value.

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
2862.43	-255.73	0.51	341.7	0.963E-02	0.86	1559.39	0.94	0.08	.70644E+05
3138.96	-255.73	0.51	377.4	0.872E-02	0.88	1681.82	0.95	0.07	.77486E+05
3415.50	-255.73	0.51	414.1	0.795E-02	0.90	1804.73	0.96	0.06	.84328E+05
3692.03	-255.73	0.51	451.7	0.728E-02	0.92	1928.06	0.97	0.05	.91170E+05
3968.56	-255.73	0.51	490.2	0.671E-02	0.94	2051.77	0.98	0.04	.98012E+05
4245.10	-255.73	0.51	529.5	0.621E-02	0.96	2175.84	0.99	0.04	.10485E+06
4521.63	-255.73	0.51	569.7	0.578E-02	0.97	2300.21	1.00	0.03	.11170E+06
4798.16	-255.73	0.51	610.7	0.539E-02	0.99	2424.88	1.01	0.02	.11854E+06
5074.69	-255.73	0.51	652.4	0.504E-02	1.00	2549.81	1.02	0.01	.12538E+06
5351.23	-255.73	0.51	694.9	0.473E-02	1.02	2674.99	1.02	0.00	.13222E+06
5627.76	-255.73	0.51	738.1	0.446E-02	1.03	2800.40	1.03	0.00	.13906E+06
5904.29	-255.73	0.51	782.1	0.421E-02	1.05	2926.02	1.05	0.00	.14591E+06

Cumulative travel time = 145905.4375 sec ( 40.53 hrs)

Plume is LATERALLY FULLY MIXED at the end of the buoyant spreading regime.

END OF MOD242: BUOYANT TERMINAL LAYER SPREADING

Due to the attachment or proximity of the plume to the bottom, the bottom  
 coordinate for the FAR-FIELD differs from the ambient depth, ZFB = 0 m.  
 In a subsequent analysis set "depth at discharge" equal to "ambient depth".

BEGIN MOD262: PASSIVE AMBIENT MIXING IN STRATIFIED AMBIENT

Vertical diffusivity (initial value) = 0.249E-07 m<sup>2</sup>/s  
 Horizontal diffusivity (initial value) = 0.610E-02 m<sup>2</sup>/s

Profile definitions:

BV = Gaussian s.d.\*sqrt(pi/2) (46%) thickness, measured vertically  
 = or equal to layer depth, if fully mixed  
 BH = Gaussian s.d.\*sqrt(pi/2) (46%) half-width,  
 measured horizontally in Y-direction  
 ZU = upper plume boundary (Z-coordinate)  
 ZL = lower plume boundary (Z-coordinate)  
 S = hydrodynamic centerline dilution  
 C = centerline concentration (includes reaction effects, if any)  
 TT = Cumulative travel time

Plume Stage 2 (bank attached):

[illegible]







## August Conditions, Low Phosphorus Cormix Session Report

```

CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
CORMIX MIXING ZONE EXPERT SYSTEM
CORMIX Version 8.UGTD
HYDRO2:Version-8.0.0.0 April,2012

SITE NAME/LABEL:      Pend Oreille River - Sandpoint outfall
DESIGN CASE:          Sandpoint WWTP TP discharge to Pend Oreille River
FILE NAME:            C:\data\ALLTECH\WATER\40icerts\sandpoint 2013\sandpoint run5.prd
Using subsystem CORMIX2:  Multiport Diffuser Discharges
Start of session:      02/01/2013--09:57:01
*****
SUMMARY OF INPUT DATA:
-----
AMBIENT PARAMETERS:
Cross-section          = bounded
Width                 BS      = 2926.08 m
Channel regularity     ICHREG = 1
Ambient flowrate       QA      = 239.22 m^3/s
Average depth          NA      = 6.71 m
Depth at discharge     HD      = 5.18 m
Ambient velocity       UA      = 0.0122 m/s
Darcy-Weisbach friction factor F = 0.0167
    Calculated from Manning's n
    = 0.02
Wind velocity          UW      = 4 m/s
Stratification Type    STRCND = A
Surface temperature     = 24 degC
Bottom temperature     = 21 degC
Calculated FRESH-WATER DENSITY values:
Surface density        RHOAS = 997.2973 kg/m^3
Bottom density         RHOAB = 997.9934 kg/m^3
-----
DISCHARGE PARAMETERS:  Submerged Multiport Diffuser Discharge
Diffuser type          DITYPE = unidirectional perpendicular
Diffuser length        LD      = 49.99 m
Nearest bank           = right
Diffuser endpoints     YB1     = 230.73 m;   YB2 = 280.72 m
Number of openings     NOPEN  = 41
Number of Risers        NRISER = 41
Ports/Nozzles per Riser NPPERR = 1
Spacing between risers/openings SPAC = 1.25 m
Port/Nozzle diameter   D0      = 0.0762 m
    with contraction ratio
    = 1
Equivalent slot width   B0      = 0.0037 m
Total area of openings TAO     = 0.1870 m^2
Discharge velocity      U0      = 0.85 m/s
Total discharge flowrate Q0     = 0.158602 m^3/s
Discharge port height   H0      = 0.41 m
Nozzle arrangement     BETYPE = unidirectional without fanning
Diffuser alignment angle GAMMA = 90 deg
Vertical discharge angle THETA = 0 deg
Actual Vertical discharge angle THEAC = 0 deg
Horizontal discharge angle SIGMA = 0 deg
Relative orientation angle BETA = 90 deg
Discharge temperature (freshwater) = 21 degC
Corresponding density   RHO0    = 997.9934 kg/m^3
Density difference      DRHO    = -0.0545 kg/m^3
Buoyant acceleration    GPO     = -0.0005 m/s^2
Discharge concentration C0      = 2.868 mg/l
Surface heat exchange coeff. KS = 0 m/s
Coefficient of decay     KD      = 0 /s
-----
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
Discharge (volume flux) q0      = 0.003173 m^2/s
Momentum flux          m0      = 0.002691 m^3/s^2
Buoyancy flux          j0      = -0.000002 m^3/s^3
-----
DISCHARGE/ENVIRONMENT LENGTH SCALES:
LQ = 0.00 m           Lm = 18.11 m           LM = 18.85 m
lm' = 1.27 m          Lb' = 0.33 m           La = 0.34 m
(These refer to the actual discharge/environment length scales.)
-----
NON-DIMENSIONAL PARAMETERS:
Slot Froude number      FRO     = 599.54
Port/nozzle Froude number FRD0  = 132.83
Velocity ratio          R        = 69.57
-----
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
Toxic discharge         = no
Water quality standard specified = yes
Water quality standard   CSTD    = 0.01 mg/l
Regulatory mixing zone   = no
Region of interest       = 50000 m downstream
*****
HYDRODYNAMIC CLASSIFICATION:
*-----*
| FLOW CLASS = MS4 |
*-----*
This flow configuration applies to a layer corresponding to the linearly
stratified density layer at the discharge site.
Applicable layer depth = water depth = 5.18 m
*****

```

MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

X-Y-Z Coordinate system:

Origin is located at the bottom below the port center:  
255.73 m from the right bank/shore.  
Number of display steps NSTEP = 20 per module.

NEAR-FIELD REGION (NFR) CONDITIONS :

Note: The NFR is the zone of strong initial mixing. It has no regulatory implication. However, this information may be useful for the discharge designer because the mixing in the NFR is usually sensitive to the discharge design conditions.

Pollutant concentration at NFR edge  $c = 0.1396$  mg/l  
Dilution at edge of NFR  $s = 20.5$   
NFR Location:  $x = 107.08$  m  
(centerline coordinates)  $y = 0$  m  
 $z = 0.38$  m

NFR plume dimensions: half-width (bh) = 206.43 m  
thickness (bv) = 0.65 m

Cumulative travel time: 8482.125 sec.

Buoyancy assessment:

The effluent density is greater than the surrounding ambient water density at the discharge level.  
Therefore, the effluent is NEGATIVELY BUOYANT and will tend to sink towards the bottom.

IMPORTANT NOTE:

Since the effluent is NEGATIVELY BUOYANT, it is STRONGLY recommended that you consider using the Brine or Sediment options for Effluent specification for a more detailed analysis.

CORMIX will however continue with the current simulation.

Stratification assessment:

The specified ambient density stratification is dynamically important.  
The discharge near field flow is trapped within the linearly stratified ambient density layer.

UPSTREAM INTRUSION SUMMARY:

Plume exhibits upstream intrusion due to low ambient velocity or strong discharge buoyancy.

Intrusion length = 101.44 m  
Intrusion stagnation point = -97.58 m  
Intrusion thickness = 0.81 m  
Intrusion half width at impingement = 206.43 m  
Intrusion half thickness at impingement = 0.65 m

In this case, the UPSTREAM INTRUSION IS VERY LARGE, exceeding ten (10) times the local water depth.

This may be caused by the small ambient velocity, perhaps in combination with the strong buoyancy of the effluent, or alternatively, a strong ambient stratification.

If the ambient conditions are quite unsteady (e.g. tidal), then the CORMIX steady-state predictions of the upstream intrusion are probably unrealistic. The plume predictions in the immediate near-field, prior to the intrusion layer formation, are acceptable, however.

FAR-FIELD MIXING SUMMARY:

Plume becomes laterally fully mixed at 1903.43 m downstream.

PLUME BANK CONTACT SUMMARY:

Plume in bounded section contacts nearest bank at 149.25 m downstream.  
Plume contacts second bank at 1903.43 m downstream.

\*\*\*\*\* TOXIC DILUTION ZONE SUMMARY \*\*\*\*\*  
No TDZ was specified for this simulation.

\*\*\*\*\* REGULATORY MIXING ZONE SUMMARY \*\*\*\*\*  
No RMZ has been specified.

However:

The ambient water quality standard was encountered at the following

plume position:

Water quality standard = 0.01 mg/l  
Corresponding dilution  $s = 286.8$   
Plume location:  $x = 1776.60$  m  
(centerline coordinates)  $y = -255.73$  m  
 $z = 0.38$  m

Plume dimensions: half-width (bh) = 2742.25 m  
thickness (bv) = 1.36 m

\*\*\*\*\* FINAL DESIGN ADVICE AND COMMENTS \*\*\*\*\*

CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent the actual three-dimensional diffuser geometry. Thus, it approximates the details of the merging process of the individual jets from each port/nozzle.

In the present design, the spacing between adjacent ports/nozzles (or riser assemblies) is of the order of, or less than, the local water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a final CORMIX1 (single port discharge) analysis, with discharge data for an individual diffuser jet/plume, in order to compare to the present near-field prediction.

REMINDER: The user must take note that HYDRODYNAMIC MODELING by any known technique is NOT AN EXACT SCIENCE. Extensive comparison with field and laboratory data has shown that the CORMIX predictions on dilutions and concentrations (with associated plume geometries) are reliable for the majority of cases and are accurate to within about  $\pm 50\%$  (standard deviation). As a further safeguard, CORMIX will not give predictions whenever it judges the design configuration as highly complex and uncertain for prediction.

[illegible]

HYDRO2 Version 8.0.0.0 April 2012

Jet-like motion in linear stratification with weak crossflow.

Zone of flow establishment: THETA= 0.00 SIGMA= 0.00  
 LE = 0.38 XE = 0.38 YE = 0.00 ZE = 0.41

Profile definitions:

BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory  
 BH = before merging: Gaussian 1/e (37%) half-width in horizontal plane  
       normal to trajectory  
       after merging: top-hat half-width in horizontal plane  
       parallel to diffuser line  
 S = hydrodynamic centerline dilution  
 C = centerline concentration (includes reaction effects, if any)  
 Uc = Local centerline excess velocity (above ambient)  
 TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	Uc	TT
Individual jet/plumes before merging:								
0.38	0.00	0.41	1.0	0.287E+01	0.04	0.04	0.836	.00000E+00
0.38	0.00	0.41	1.0	0.287E+01	0.04	0.04	0.836	.31834E-02
Maximum jet height has been reached.								
0.55	0.00	0.41	1.3	0.227E+01	0.06	0.06	0.782	.18551E+00
0.73	0.00	0.41	1.7	0.170E+01	0.08	0.08	0.586	.44387E+00
0.90	0.00	0.41	2.1	0.136E+01	0.09	0.09	0.471	.76657E+00
1.08	0.00	0.40	2.5	0.113E+01	0.11	0.11	0.392	.11669E+01
1.25	0.00	0.40	3.0	0.967E+00	0.13	0.13	0.336	.16379E+01
1.42	0.00	0.40	3.4	0.846E+00	0.15	0.15	0.294	.21667E+01
1.60	0.00	0.40	3.8	0.750E+00	0.17	0.17	0.261	.27755E+01
1.77	0.00	0.40	4.2	0.675E+00	0.18	0.18	0.236	.34378E+01
1.95	0.00	0.40	4.7	0.612E+00	0.20	0.20	0.214	.41818E+01
2.12	0.00	0.40	5.1	0.560E+00	0.22	0.22	0.196	.49931E+01
2.30	0.00	0.40	5.6	0.516E+00	0.23	0.23	0.181	.58518E+01
2.47	0.00	0.40	6.0	0.478E+00	0.25	0.25	0.168	.67945E+01
2.64	0.00	0.40	6.4	0.446E+00	0.27	0.27	0.157	.77806E+01
2.82	0.00	0.40	6.9	0.417E+00	0.28	0.28	0.147	.88524E+01
3.00	0.00	0.39	7.3	0.392E+00	0.30	0.30	0.138	.99885E+01
3.17	0.00	0.39	7.8	0.370E+00	0.32	0.32	0.131	.11162E+02
3.34	0.00	0.39	8.2	0.349E+00	0.33	0.33	0.124	.12424E+02
3.52	0.00	0.39	8.7	0.332E+00	0.35	0.35	0.118	.13720E+02
3.69	0.00	0.38	9.1	0.315E+00	0.37	0.37	0.112	.15105E+02
3.87	0.00	0.38	9.5	0.300E+00	0.38	0.38	0.107	.16521E+02
Cumulative travel time = 16.5209 sec ( 0.00 hrs)								
Merging of individual jet/plumes not found in this module, but interaction will occur in following module. Overall jet/plume interaction dimensions:								
3.87	0.00	0.38	9.5	0.300E+00	0.38	25.03	0.107	.16521E+02

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

BEGIN MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING

UPSTREAM INTRUSION PROPERTIES:

Maximum elevation of jet/plume rise = 3.08 m  
 Layer thickness in impingement region = 0.81 m  
 Upstream intrusion length = 101.44 m  
 X-position of upstream stagnation point = -97.58 m  
 Thickness in intrusion region = 0.81 m  
 Half-width at downstream end = 206.43 m  
 Thickness at downstream end = 0.65 m

In this case, the upstream INTRUSION IS VERY LARGE, exceeding 10 times the local water depth.

This may be caused by a very small ambient velocity, perhaps in combination with large discharge buoyancy.

If the ambient conditions are strongly transient (e.g. tidal), then the CORMIX steady-state predictions of upstream intrusion are probably unrealistic.

The plume predictions prior to boundary impingement and wedge formation will be acceptable, however.

Control volume inflow:

X	Y	Z	S	C	BV	BH	TT
3.87	0.00	0.38	9.5	0.300E+00	0.38	25.03	.16521E+02

Profile definitions:

BV = top-hat thickness, measured vertically  
 BH = top-hat half-width, measured horizontally in y-direction  
 ZU = upper plume boundary (Z-coordinate)  
 ZL = lower plume boundary (Z-coordinate)  
 S = hydrodynamic average (bulk) dilution  
 C = average (bulk) concentration (includes reaction effects, if any)  
 TT = Cumulative travel time

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
-97.58	0.00	0.38	9999.9	0.000E+00	0.00	0.00	0.38	0.38	.84821E+04
-93.48	0.00	0.38	37.9	0.756E-01	0.20	29.19	0.48	0.28	.16521E+02
-73.43	0.00	0.38	15.8	0.182E+00	0.49	70.91	0.63	0.14	.16521E+02
-53.37	0.00	0.38	12.0	0.239E+00	0.64	95.94	0.70	0.06	.16521E+02
-33.31	0.00	0.38	10.4	0.275E+00	0.74	115.67	0.75	0.01	.16521E+02
-13.26	0.00	0.38	9.7	0.295E+00	0.79	132.50	0.79	0.00	.16521E+02
6.80	0.00	0.38	9.6	0.299E+00	0.80	188.96	0.80	0.00	.25698E+03
26.85	0.00	0.38	11.5	0.249E+00	0.78	192.97	0.78	0.00	.19020E+04
46.91	0.00	0.38	15.1	0.190E+00	0.73	196.66	0.74	0.02	.35470E+04

66.97	0.00	0.38	18.1	0.159E+00	0.68	200.11	0.72	0.04	.51921E+04
87.02	0.00	0.38	19.7	0.145E+00	0.66	203.35	0.71	0.05	.68371E+04
107.08	0.00	0.38	20.5	0.140E+00	0.65	206.43	0.71	0.06	.84821E+04

Cumulative travel time = 8482.1250 sec ( 2.36 hrs)

END OF MOD237: TERMINAL LAYER INJECTION/UPSTREAM SPREADING

-----  
 \*\* End of NEAR-FIELD REGION (NFR) \*\*  
 -----

BEGIN MOD242: BUOYANT TERMINAL LAYER SPREADING

Profile definitions:

BV = top-hat thickness, measured vertically  
 BH = top-hat half-width, measured horizontally in y-direction  
 ZU = upper plume boundary (Z-coordinate)  
 ZL = lower plume boundary (Z-coordinate)  
 S = hydrodynamic average (bulk) dilution  
 C = average (bulk) concentration (includes reaction effects, if any)  
 TT = Cumulative travel time

Plume Stage 1 (not bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
107.08	0.00	0.38	20.5	0.140E+00	0.65	206.43	0.71	0.06	.84821E+04
109.19	0.00	0.38	20.8	0.138E+00	0.65	208.87	0.71	0.06	.86549E+04
111.30	0.00	0.38	21.1	0.136E+00	0.65	211.32	0.71	0.06	.88278E+04
113.40	0.00	0.38	21.4	0.134E+00	0.65	213.77	0.71	0.06	.90006E+04
115.51	0.00	0.38	21.7	0.132E+00	0.65	216.22	0.71	0.06	.91734E+04
117.62	0.00	0.38	22.0	0.130E+00	0.65	218.68	0.71	0.05	.93462E+04
119.73	0.00	0.38	22.3	0.129E+00	0.66	221.13	0.71	0.05	.95190E+04
121.84	0.00	0.38	22.6	0.127E+00	0.66	223.59	0.71	0.05	.96918E+04
123.95	0.00	0.38	22.9	0.125E+00	0.66	226.05	0.71	0.05	.98646E+04
126.05	0.00	0.38	23.2	0.124E+00	0.66	228.51	0.71	0.05	.10037E+05
128.16	0.00	0.38	23.5	0.122E+00	0.66	230.97	0.71	0.05	.10210E+05
130.27	0.00	0.38	23.8	0.120E+00	0.66	233.43	0.71	0.05	.10383E+05
132.38	0.00	0.38	24.1	0.119E+00	0.66	235.90	0.71	0.05	.10556E+05
134.49	0.00	0.38	24.4	0.117E+00	0.67	238.37	0.71	0.05	.10729E+05
136.60	0.00	0.38	24.7	0.116E+00	0.67	240.84	0.72	0.05	.10902E+05
138.70	0.00	0.38	25.0	0.115E+00	0.67	243.31	0.72	0.05	.11074E+05
140.81	0.00	0.38	25.4	0.113E+00	0.67	245.78	0.72	0.05	.11247E+05
142.92	0.00	0.38	25.7	0.112E+00	0.67	248.26	0.72	0.05	.11420E+05
145.03	0.00	0.38	26.0	0.110E+00	0.67	250.74	0.72	0.04	.11593E+05
147.14	0.00	0.38	26.3	0.109E+00	0.68	253.22	0.72	0.04	.11766E+05
149.25	0.00	0.38	26.6	0.108E+00	0.68	255.70	0.72	0.04	.11938E+05

Cumulative travel time = 11938.3955 sec ( 3.32 hrs)

-----  
 Plume is ATTACHED to RIGHT bank/shore.

Plume width is now determined from RIGHT bank/shore.

Plume Stage 2 (bank attached):

X	Y	Z	S	C	BV	BH	ZU	ZL	TT
149.25	-255.73	0.38	26.6	0.108E+00	0.68	511.45	0.72	0.04	.11938E+05
236.96	-255.73	0.38	37.6	0.763E-01	0.80	608.60	0.80	0.00	.19128E+05
324.66	-255.73	0.38	48.2	0.595E-01	0.88	716.42	0.88	0.00	.26317E+05
412.37	-255.73	0.38	59.2	0.484E-01	0.93	829.36	0.93	0.00	.33506E+05
500.08	-255.73	0.38	70.7	0.406E-01	0.97	945.29	0.97	0.00	.40695E+05
587.79	-255.73	0.38	82.7	0.347E-01	1.01	1063.22	1.01	0.00	.47885E+05
675.50	-255.73	0.38	95.2	0.301E-01	1.05	1182.62	1.05	0.00	.55074E+05
763.21	-255.73	0.38	108.1	0.265E-01	1.08	1303.18	1.08	0.00	.62263E+05
850.92	-255.73	0.38	121.5	0.236E-01	1.11	1424.70	1.11	0.00	.69452E+05
938.63	-255.73	0.38	135.4	0.212E-01	1.14	1547.02	1.14	0.00	.76641E+05
1026.34	-255.73	0.38	149.7	0.192E-01	1.17	1670.05	1.17	0.00	.83831E+05
1114.05	-255.73	0.38	164.4	0.174E-01	1.19	1793.69	1.19	0.00	.91020E+05
1201.76	-255.73	0.38	179.4	0.160E-01	1.22	1917.88	1.22	0.00	.98209E+05
1289.47	-255.73	0.38	194.9	0.147E-01	1.24	2042.56	1.24	0.00	.10540E+06
1377.18	-255.73	0.38	210.7	0.136E-01	1.26	2167.69	1.26	0.00	.11259E+06
1464.88	-255.73	0.38	226.8	0.126E-01	1.29	2293.23	1.29	0.00	.11978E+06
1552.59	-255.73	0.38	243.3	0.118E-01	1.31	2419.15	1.31	0.00	.12697E+06
1640.30	-255.73	0.38	260.1	0.110E-01	1.33	2545.41	1.33	0.00	.13416E+06
1728.01	-255.73	0.38	277.2	0.103E-01	1.35	2671.99	1.35	0.00	.14134E+06

\*\* WATER QUALITY STANDARD OR CCC HAS BEEN FOUND \*\*

The pollutant concentration in the plume falls below water quality standard

or CCC value of 0.100E-01 in the current prediction interval.

This is the spatial extent of concentrations exceeding the water quality standard or CCC value.

1815.72	-255.73	0.38	294.6	0.973E-02	1.37	2798.88	1.37	0.00	.14853E+06
1903.43	-255.73	0.38	312.3	0.918E-02	1.39	2926.03	1.39	0.00	.15572E+06

Cumulative travel time = 155722.9688 sec ( 43.26 hrs)

Plume is LATERALLY FULLY MIXED at the end of the buoyant spreading regime.

END OF MOD242: BUOYANT TERMINAL LAYER SPREADING

-----  
 Due to the attachment or proximity of the plume to the bottom, the bottom coordinate for the FAR-FIELD differs from the ambient depth, ZFB = 0 m.  
 In a subsequent analysis set "depth at discharge" equal to "ambient depth".  
 -----

BEGIN MOD262: PASSIVE AMBIENT MIXING IN STRATIFIED AMBIENT

Vertical diffusivity (initial value) = 0.834E-07 m<sup>2</sup>/s  
 Horizontal diffusivity (initial value) = 0.598E-02 m<sup>2</sup>/s



```

PR = 1
BV = Gaussian s.d.*sqrt(pi/2) (46%) thickness, measured vertically
    = or equal to layer depth, if fully mixed
BH = Gaussian s.d.*sqrt(pi/2) (46%) half-width,
    measured horizontally in Y-direction
ZU = upper plume boundary (Z-coordinate)
ZL = lower plume boundary (Z-coordinate)
D = hydrodynamic centerline dilution
C = centerline concentration (includes reaction effects, if any)
TT = Cumulative travel time

```

[illegible]

END OF MOD262: PASSIVE AMBIENT MIXING IN STRATIFIED AMBIENT

[illegible]